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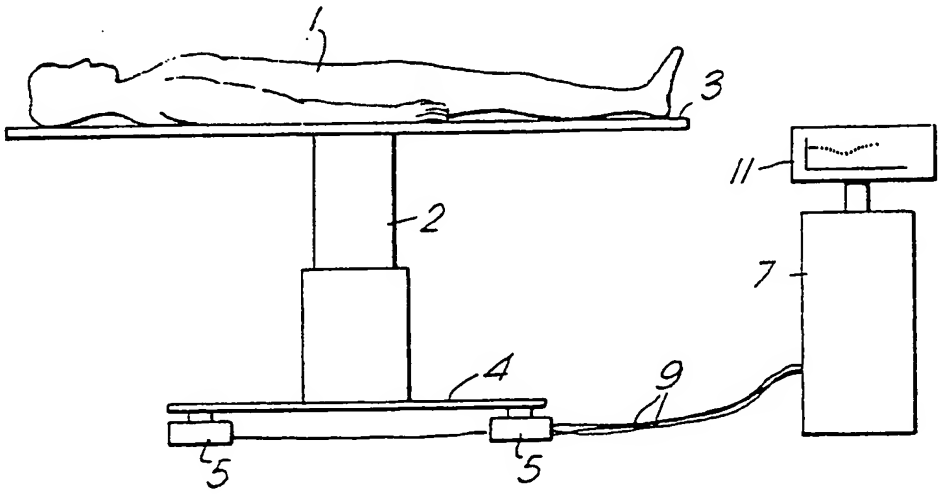
(54) Measuring the fluid balance of a patient during surgery

(57) The fluid balance of a patient (1) during surgery is measured by periodically weighing the patient. The weight values are processed to remove unwanted fluctuations and transient effects. Preferably the patient is weighed using strain gauges (5) placed in or underneath the operating table (3) and the system is tared after the patient is placed on the table. The data is preferably displayed graphically (11) relative to a reference weight so that the change in the patient's weight during the course of the operation can be seen.

Fig. 1.



At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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A METHOD AND APPARATUS FOR MEASURING THE FLUID BALANCE OF A PATIENT DURING SURGERY

The present invention relates to a method and apparatus for measuring the fluid balance of a patient during surgery, in particular during transurethral resection of the prostate.

During transurethral resection of the prostate (TURP) it is necessary to have a good view of the prostatic fossa to enable careful guidance of the cutting diathermy loop. An exceptionally clear view is vital because poor vision resulting in a single misplaced cut may cause permanent incontinence in the patient. A clear view of the prostatic cavity is achieved by the provision of a continuous flow of irrigating solution via the resectoscope. The solution dilates the prostatic cavity and washes the resected tissue and blood away; the irrigant is either removed continuously via another channel in the instrument or at intervals by removal of the resectoscope from its sheath.

Regardless of the method of irrigation, variable quantities of the irrigating solution are absorbed during the operation. Large quantities may severely overload the patient's circulation, leading to cardiovascular collapse and toxic effects. Studies have observed that irrigating solution may be absorbed directly into the circulation at a rate of 190 ml/min. Another study has reported a case in which seven litres of irrigant were absorbed in less than one hour while further studies have indicated that the concentrations of irrigating fluid solute in the circulation after surgery can range from 40 ml to 2.8 l. Another factor contributing to the overall fluid balance of the patient is haemorrhage, which also occurs variably.

According to the present invention, there is provided a method of measuring the fluid balance of a patient during surgery, comprising the steps of:

monitoring the weight of said patient and producing raw data indicative of said weight;

processing said raw data to compensate for factors other than changes in said fluid balance to produce a corrected weight; and

providing an indication of said corrected weight so that changes in said fluid balance can be observed.

The present invention also provides an apparatus for monitoring the fluid balance of a patient, said apparatus comprising weighing means for weighing said patient and producing raw data indicative of said weight of said patient;

processing means for processing said raw data to compensate for factors other than changes in said fluid balance, to produce a corrected weight;

means for deriving from the corrected weight an indication of the fluid balance.

Preferably, the means for providing an indication of said weight comprise means for displaying the change in the patient's weight from a reference point established at the beginning of an operation and what is displayed are the changes from that reference during the course of the operation.

The weighing of the patient is preferably carried out using strain gauge transducers and may either involve weighing the whole operating table or, if a special support for the patient is provided, the patient alone. Sudden large changes in weight resulting from extra objects being placed on the operating table also need to be eliminated so

Figure 2 is a schematic diagram showing the processing of data from the load cells (5). The load cells (5) are connected to a balancing circuit (12) which balances the data from the three cells and passes it to a Digital weighmeter (13) (for example a Gedge Systems GS 1650) which converts this to a weight value, which is periodically output. The particular weightmeter used produces a value every three seconds. This weight is passed to a bad data filter (15) which eliminates obviously erroneous data by reference to defined criteria. For example data could be rejected on the basis that it falls outside a prescribed range of values. This is especially necessary in TURP as the Diathermal loop used to section the prostate emits a large amount of radio frequency noise which can cause random errors in the weight signal of the order of 20 kg.

The remaining data is passed to a second filter (17) which only accepts a datum if it is within a specified range of the previous data, for example 100 g, representing the largest change in weight when the interval between samples that is likely to be attributable to a change in fluid balance. The output of this is passed to an averaging filter (19) which takes a mean over a suitable period, for example 15 seconds so as to reduce the effect of transient fluctuations, for example due to the actions of the surgeon, and passes it to the display controller 21 for further smoothing and display on the display (11).

The display (11) is a graphical display with time along the abscissa and weight along the ordinate. Raw and semi-filtered data may also be displayed in separate data windows. A numerical display of the corrected weight may also be provided. The corrected weight display is updated at appropriate intervals, for example every 15 seconds or

C L A I M S

1. An apparatus for monitoring the fluid balance of a patient, said apparatus comprising weighing means for weighing said patient and producing raw data indicative of said weight of said patient;

processing means for processing said raw data to compensate for factors other than changes in said fluid balance, to produce a corrected weight;

means for deriving from the corrected weight an indication of the fluid balance.

2. An apparatus according to claim 1, wherein said weighing means comprise at least one strain gauge.

3. An apparatus according to claim 2, wherein said at least one strain gauge is placed underneath said operating table during surgery so as to bear the weight of the operating table.

4. An apparatus according to claim 2, wherein said at least one strain gauge is placed in a central column supporting the operating table so as to support the weight of the patient and the operating table.

5. An apparatus according to claim 1 or 2, wherein said weigh means is incorporated in a stand supporting the operating table.

6. An apparatus according to any one of claims 1 to 5, wherein said weighing means comprises means for balancing the data of said at least one strain gauge and providing balanced data indicative of said weight of said patient.

7. An apparatus according to claim 6, wherein said weighing means includes a digital weighmeter responsive to said balanced data for providing said raw data.

8. An apparatus according to any one of claims 1 to 7, wherein said processing means include a first data filter which eliminates data falling outside a first predetermined range of values.

17. A method according to claim 15 or 16, wherein said step of processing said raw data includes the step of eliminating data which falls outside a second predetermined range of a predetermined number of previous data samples.

18. A method according to claim 15, 16 or 17, wherein said step of processing said raw data includes the step of averaging said data over a predetermined period.

19. A method according to any one of claims 15 to 18, wherein said step of processing said raw data includes the step of taring said weight to provide a reference value such that subsequent corrected weight values each represents the difference between the current weight of the patient and the reference value.

20. A method according to any one of claims 15 to 19, wherein said step of providing an indication of said corrected weight includes the step of providing a graphical display of said corrected weight and the changes therein during said surgery.

21. A method according to any one of claims 15 to 20, wherein said step of providing an indication includes the step of displaying said raw data and/or partly processed data.

22. A method according to any one of claims 15 to 21, wherein said step of providing an indication of said corrected weight includes the step of displaying a numerical value representing said corrected weight.

23. A method of measuring the fluid balance of a patient during surgery, the method being substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

24. An apparatus for carrying out the method of any one of claims 15 to 23.